Description of Groundwater Status Assessment Methodologies

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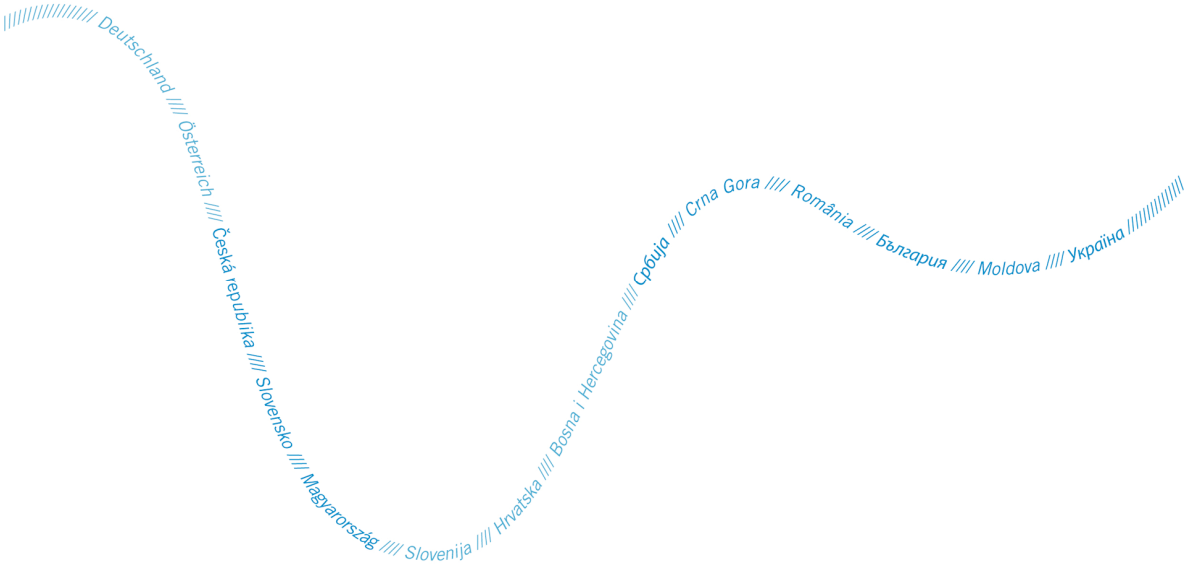

Description of status assessment methodology applied for GWBs in Hungary

HU: *Chemical Status Assessment*

1. Exceedance of threshold values at monitoring points

The test is performed for all GWBs and for all chemical elements, for which standard or threshold value(s) have been determined, in the following steps.

- To select WFD monitoring points where the average concentration of the period 2004-2007 ***exceeds the determined standard or the threshold value***.

- To exclude monitoring sites where the higher concentration is due to ***natural conditions*** (although the threshold value is determined considering natural background level, it is possible to detect an exceedance of natural origin).

- To classify directly in poor status all those GWBs, where a ***drinking water production well or captured spring*** shows exceedance of the drinking water standard in such an extent that changes in treatment technology is needed. GWB should be classified as poor in case of danger of pollution of drinking water production wells. (see next point for potential impact on active abstractions).

- To evaluate data on groundwater quality ***inside the drinking water source protection area*** (corresponding to 50 years travel time, according to the Hungarian legislation). The evaluation is carried out in the frame of the general status assessment of the exploited drinking water resources, including all observation wells and information on sources of pollution. If the result of evaluation shows that pollution is able to cause exceedance of the drinking water standard at the abstraction point involving change in treatment technology, the GWB is classified in poor status.

- To select monitoring wells ***inside aquifers designated for future drinking water abstraction.*** If the number of wells exceeding the drinking water standard is higher than a given value (determined in function of the chemical element and the type of the aquifer), the GWB is classified in poor status since it is likely that the exploitation would be difficult: not possible or would need treatment.

- The real impact of exceedances on ecosystems is analysed according to points 3.&4.

Where the NBL > DWS the TV is taken into consideration.

2. Delineation of polluted areas

This test is carried out for ***shallow and karstic GWBs regarding nitrate and ammonium***.

The delineation of the polluted area (where the concentration exceeds the threshold of the given GWB) is based on all information (not only WFD monitoring!).

The GWB is classified in poor status if ***20 – 30% of the total surface of the GWB is polluted.*** For a given GWB, the criterion is selected according to its vulnerability: i.e. for karstic aquifers: and for GWB of recharge character 20 %,: for other shallow GWBs: 30%.

3. Polluted surface water bodies

The test is applied for those GWBs where for a groundwater dependent ***surface water body the physico-chemical or the chemical test shows poor status***, and its reason is not evidently sewage water discharges or diffuse pollution from surface runoff. Those cases shall also be analysed where polluted

monitoring well can be found in the vicinity (closer than 5 km) of a groundwater dependent surface water body of poor chemical status.

The evaluation is special for each case, taking into account (i) all available data on groundwater and surface water quality, (ii) information on pollution sources - the point or diffuse character of the pollution, (iii) estimated load from pollution sources, (iv) attenuation and dilution effect. If it is proved that the chemical status of the GWB is the cause of the observed pollution in the surface water body, the GWB is classified in poor chemical status.

The real impact of ***polluted springs*** on the quality of the supplied water course is also evaluated, at least until the first water body (considering possible dilution). If the physico-chemical or chemical status of the surface water body (!) is not good because of this pollution, the GWB is classified in poor status.

4. Damaged groundwater dependent wetland and terrestrial ecosystems

The test is applied for those GWBs where it is likely that the ***documented damage of certain wetlands or GWDTE*** is due to the polluted groundwater. The methodology of the evaluation of the real impact on the ecosystems is performed in a similar way than in the case of aquatic ecosystems (see point 3.). Monitoring of the status of wetlands and GWDTEs is not part of the WFD, so only scattered info on status is available.

HU: *Quantitative Status Assessment*

1. Test of water balance

The test of water balance is carried out in two steps:

- The GWB is in poor status if ***in 20% of its area continuous decreasing water level*** can be observed due to groundwater abstraction.

  The test is based on data of the period 2001-2007. A declining trend of 5-15 cm/year (depends on aquifer types and depth) can be considered as significant. In mountainous region, the rate of springs are also analysed, the significant trend depends on the average rate. Water abstractions causing the trend should be identified. (Trend caused by meteorological conditions or short declining trend caused by new water abstractions is not considered.). If the designated area is in the vicinity of the country border, ***transboundary conciliation is needed***.

- The GWB is in poor status too, if the ***groundwater abstraction exceeds the available groundwater resource***.

  This test is applied for subsurface catchment areas, thus shallow and deeper GWBs (except porous thermal GWB) and corresponding dominantly recharge and discharge GWBs are merged in GWB-groups.

  The recharge consists of three components: (i) recharge from precipitation, (ii) recharge from surface water, (iii) flow from adjacent GWB or GWB-group.

  The recharge from precipitation is calculated by a spatially distributed (1x1 km grid) water balance model including precipitation (period 1991-2000), interception, surface runoff, evapotranspiration and storage in the unsaturated zone.

  Recharge from surface water (as longterm average) is rare in Hungary, it is determined in a case by case basis.

  Although GWBs are grouped according to subsurface catchments, estimation of ***flow from adjacent GWB-group*** is still important (i) in the case of transboundary water bodies, (ii) between different types of GWB-s, (iii) where the boundary in the deeper part does not represent real no-flux boundary. The estimation is based on the results of regional groundwater flow models or simple calculation using the maps of water levels and transmissibility.

The water demand of the groundwater dependent ecosystems has also three components: (i) baseflow and spring rates supplying aquatic ecosystems in water courses, (ii) surplus of evaporation of shallow lakes and wetlands, (iii) surplus of transpiration from groundwater (supplying GWDTE).

Water demand of aquatic ecosystem in rivers is considered for small and medium water courses, where springs are frequent in the catchment or where the average groundwater level is above the bottom of the riverbed. Ecologically necessary low flow is estimated on the basis of required water depth, width and velocity.

Water demand of shallow lakes and wetlands is estimated as the product of required water/wetland surface and surplus of evaporation. The required water surface is estimated considering landscape-ecological aspects.

Water demand of the vegetation in discharge area is estimated as the product of the area (where the groundwater should contribute significantly to the water supply of the vegetation) and the amount of capillary flow needed for surviving periods without precipitation. The potential area is delineated using GIS procedure (convenient combination of soil type and groundwater level). The required part is some percentage of the potential one (default is 30%).

The amount of abstracted water is the sum of the amount abstracted by wells (average of the period 2004-2007) and the outflow related to other water uses (e.g. drainage canals, gravel pits, decreased surface water level).

2. Test of surface waters

The test is applied for those GWBs where for a groundwater dependent water body the hydromorphological classification shows critical flow situation and its reason is not evidently the use of surface waters. The groundwater body is classified as poor status:

- ***if the remaining spring rate*** in low flow period (either due to abstraction by wells or due to the capture of spring) is smaller than the ecologically required flow,

- ***if the decrease of the baseflow*** caused by groundwater abstraction (in the whole catchment of the surface water body) exceeds the half of the available surface water resource.

3. Test of groundwater dependent wetlands and terrestrial ecosystems

The test (status evaluation) is to be applied for those GWBs, where the available information shows significant damage of wetlands and GWDTE.

- It is preferred, that the real effect of the groundwater status is determined by a case by case approach, including the analysis of the ***role of the groundwater levels and flow conditions in the damage of the biota*** and the reason of it (e.g. groundwater abstraction or other water use, but climate change is not considered as a reason for bad status).

- Maybe a detailed analysis is not possible because of limited available data. In that case the GWB is in poor status if there are ***direct and indirect groundwater abstractions whose recharge area overlaps in more than 30% with the recharge area of the ecosystem***.

Description of status assessment methodology applied for GWBs in Romania

RO: *Chemical Status Assessment*

The methodology for the *chemical status* assessment generally followed the recommendations of the WGC in the document "Towards a guidance on groundwater *chemical status* and threshold values". The first step was to check any exceedances of TVs. As exceedances of TVs were recorded for the following parameters: NH_4, NO_3, NO_2, PO_4, Pb, and As, the following relevant tests where carried out:

- **General assessment of the *chemical status*:** Data aggregation was performed and it was checked whether the total area of exceedance was greater than 20% of the total area of the GWB. The test showed a *good status* for the water body.
- **Saline or other intrusion:** not relevant.
- **Significant diminution of associated surface water chemistry and ecology due to transfer of pollutants from the GWB:** The location of the exceedance of the relevant TVs was not found in areas where pollutants might be transferred to surface waters. A comparison of the pollutant load transferred from the GWB to the surface water body with the total load in the surface water body did not exceed 50%. The test showed a *good status* for the water body.
- **Significant damage to GWDTEs due to transfer of pollutants from the GWB:** No GWDTE was found to be damaged. The test showed a *good status* for the water body;
- **Meets the requirements of WFD Article 7(3) –** Drinking Water Protected Areas: there is no evidence of increased treatment due to changes in water quality. The test showed a *good status* for the water body

RO: *Quantitative Status Assessment*

The quantitative status assessment was carried out after the *chemical status* assessment. As the *chemical status* was assessed as *good* and no sustained downward trend in water levels was recorded across the water body (at any monitoring point), the water body was found to be in *good quantitative status*

Description of status assessment methodology applied for GWBs in Slovak Republic

SK: *Chemical Status Assessment*

To assess *chemical status*, the proposed methodology stems from the feasibility of the input information, conceptual model and the hydrogeochemical and hydrogeological interpretation of conditions in the Slovak Republic. Article 3.2 of the Groundwater Directive offers the possibility to establish TVs at: the national level; the river basin district level; the level of the area of the international river basin district falling within the territory of a Member State; or at the level of a GWB or group of GWBs. In the Slovak Republic, the NBL and TVs were established at the level of the GWB.

Determination of natural background levels:

The input data consists of the database from the Geochemical Atlas of the Slovak Republic (spatial factor, 16 359 samples) and the results of national monitoring of groundwater quality (time factor, 16 475 samples) in Slovakia. The next step was to eliminate each sample with anthropogenic impacts (pre-selection method with half the DWS for each compound). Sample elimination was also done in cases where just one compound failed to satisfy this principle. For determination of the NBL, a statistical method was used (NBL=median+2*median absolute deviation). For the treatment of *less than LOQ* (limit of quantification), measurements were applied according to the following system: simple substitution (LOQ*0.5, when <40% values are below LOQ), 40-60% - Kaplan-Meier´s analysis was used and over 60% NBL=LOQ). NBL were estimated for: NO_3, As, Cd, Pb, Hg, NH_4, Cl, SO_4, Na, K, Ca, Mg, Sr, PO_4, HCO_3, Fe, Mn, Cr, Cu, Se and Al. For synthetic organic compounds (not originating in a natural way) the NBL was “zero concentration” and this is practically the value of the LOQ of a single organic compound.

Threshold values:

The TV is a half the interval between the determined NBL and the reference (drinking water standard). As the TV can be below the geogenic concentration in groundwater, for example in the case of heavy metals, the TV will be assessed on the basis of the natural background level (TV = NBL).

Chemical status:

For *chemical status* assessment, general assessment of the *chemical status* of the GWB as a whole was applied. Input data results from the quality monitoring network from 2007 were used. Criteria for assessing the groundwater *chemical status* for this test were drinking water standards and TVs. The annual arithmetic mean concentration of the relevant pollutant at each monitoring point was the basis for aggregation on the level of a GWB. In the case of non exceedances, the GWB is recommended to be of good *chemical status* for the relevant parameters. The next step was to calculate the extent of exceedance of mean values by using the Kriging method - in the case of quaternary GWB (porous permeability and over five monitoring points). An acceptable extent of exceedance would not exceed 20% of the total GWB. In the case of pre-quaternary GWBs with fissure, karst, karst-fissure

permeability, annual average concentrations with 20% confidence intervals were used. The final assessment of the *chemical status* of the GWB and its verification was performed using a GIS technique via comparison with maps of land use, hydrogeological and hydrogeochemical conditions in the GWB.

SK: *Quantitative Status Assessment*

To determine the overall quantitative status for GWBs, four tests were applied:

1. Water balance test: Long-term annual abstraction from the GWB must not exceed 80% of available groundwater resources. Quantification of available groundwater resources was based on national quantification and categorization of exploitable groundwater amounts in individual GWBs: 8 categories with different accuracies for determined amounts varying from 100% (water balance evaluation) to 30% (less then 1 year of groundwater monitoring data); available groundwater resources for GWB is the sum of groundwater amount in the individual category multiplied by the different significance from 1 to 0.3).

2. Groundwater level and discharge test: Identifying the presence of sustained long-term declines in groundwater levels or groundwater discharge caused by long-term groundwater abstraction using long-term groundwater monitoring data from the national groundwater monitoring network and the Mann-Kendall test (95% and 99% probability, z varying from absolute min to -3.0).

3. Surface water flow test: Evaluation of surface water discharge in surface water balance profiles (inside of surface water bodies failing their WFD environmental flow objectives). The sum of the long-term average groundwater abstraction in the balance area above the surface water balance profile must not exceed 50% from $Q_{180\ (2007)}$ or 100% from Q_{355} (whole monitoring period).

4. Groundwater dependent terrestrial ecosystems test: Expert judgment on GWDTEs and the influence of groundwater abstraction - groundwater pressures (and subsequently indication of flow or groundwater level changes due to groundwater abstraction) on GWDTEs. The assessments were made on the basis of selected ecological criteria's and under the umbrella of the National Institute of Land Ecology (Slovak Academy of Sciences).

SK: *Procedure And Relationship To Background Levels*

To establish TVs as criteria, usage criteria were considered (drinking water standards). TVs were set by comparing natural background levels to the criteria value (CV). When NBLs and CVs are compared, two situations may arise:

- NBL is below the CV. In this case the TV was established above the NBL.

- NBL is higher than the CV. In this case, the TV should be equal to the NBL.

The TV is half of the interval between the determined NBL and the reference (drinking water standards). As the TV can be below geogenic concentrations in groundwater, for example in the case of heavy metals, the TV will be assessed on the basis of the natural background level (TV = NBL).